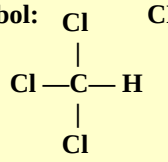
Chloroform

Symbol: $CHCl_3$



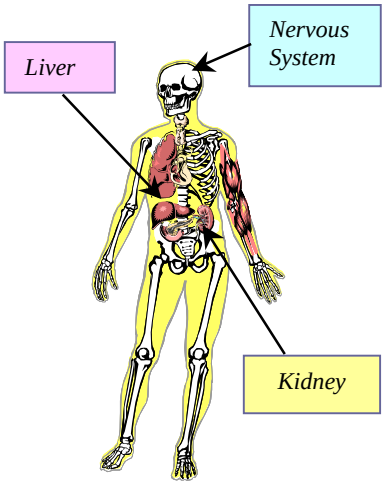
Molecular Weight: 119

What Is It? Chloroform, $CHCl_3$, is a non-flammable, colorless liquid with a pleasant, non-irritating odor and slightly sweet taste. This chemical is also known as trichloromethane or methyltrichloride. When left exposed to air, it enters the atmosphere as a gas, where it has a half-life of about 80 days. (The chemical half-life is the time it takes half the initial amount to be broken down.) Chloroform decomposes to form toxic phosgene and hydrogen chloride. It is slightly soluble in water. Most people can smell chloroform in the air at concentrations of about 133 to 276 parts per million (ppm).

How Is It Used? Chloroform is used primarily in the production of chlorodifluoromethane (a refrigerant in home air conditioners and supermarket freezers) and fluoropolymers. It is also used as an intermediate in the production of plastics, pharmaceuticals, dyes, and pesticides; as a heat transfer medium in fire extinguishers; and as a general solvent. In the past, chloroform was used extensively as an anesthetic during surgery, but that use has been discontinued.

What's in the Environment? Chloroform commonly enters the environment from manufacturing processes at industrial facilities, including chemical companies that produce or use chloroform and paper mills. It is also formed as a byproduct of chlorinating drinking water and the wastewater from sewage treatment plants. (Chlorine is added to these waters to kill bacteria.) Chloroform can also be released into the air during household use of water that contains it, including during showering. Most chloroform that enters the environment eventually reaches the atmosphere. The amount of chloroform typically measured in U.S. air ranges from 0.02 to 0.05 parts of chloroform per billion parts of air (ppb), but concentrations as high as 610 ppb have been measured in air at a municipal landfill. Concentrations of chloroform in public water supplies generally range from 2 to 44 ppb, although concentrations as high as 311 ppb have been detected. Little information is available on concentrations in soil, surface water, and groundwater in uncontaminated areas. However, soil concentrations are expected to be very low given the tendency of chloroform to either volatilize or move through soil to groundwater. The concentration associated with soil particles has been estimated to be about 30% of that in interstitial water (in pore spaces between soil particles). The highest concentrations of chloroform in groundwater at Hanford are in the 200 West Area.

What Happens to It in the Body? Chloroform can enter the body by breathing air, eating food, or drinking water containing the chemical and it can also be absorbed through the skin. When chloroform is inhaled, up to 75% is retained in the body and nearly all ingested chloroform is retained. Although chloroform is carried by the blood to all parts of the body, it tends to accumulate in tissues with high concentrations of lipids or fats. The tissues with the highest concentrations are adipose, brain, liver, kidney, and blood. Chloroform is metabolized in the body and the major end product is carbon dioxide. Studies have shown that over 96% of inhaled chloroform is exhaled through the lungs within 8 hours, mainly as carbon dioxide and unchanged chloroform. Only a small amount leaves the body in urine and feces.



Primary organs and systems affected when chloroform is taken in through food, water, or air.

What Are the Primary Health Effects? At high concentrations, chloroform is a central nervous system depressant, inducing both narcosis and anesthesia (unconsciousness). Inhaling somewhat lower concentrations (about 900 ppm) for a short time may cause fatigue, dizziness, and headache. Exposure to relatively low levels of chloroform in air or water for long periods of time can damage the liver and kidneys, and skin sores have been reported following direct contact with chloroform. Reproductive and birth defects have been

reported in laboratory animal studies. Miscarriages in pregnant (female) rats and mice as well as abnormal sperm (males) were reported following exposure to between 30 and 400 ppm of chloroform in air. It is not known if chloroform causes reproductive effects in humans.

Some studies suggest a relationship between the ingestion of chlorinated water and cancer of the colon and bladder in humans. Cancer of the liver and kidney has been observed in rats and mice exposed to elevated levels of chloroform in food and drinking water. The Environmental Protection Agency (EPA) Proposed Guidelines for Carcinogen Risk Assessment indicate that chloroform is considered likely to be carcinogenic to humans by all routes of exposure under *high-exposure* conditions that lead to cytotoxicity and regenerative hyperplasia in susceptible tissues. However, chloroform is *not likely to be carcinogenic to humans by any route of exposure* under lower exposure conditions that do not cause cell toxicity and abnormal growth/regeneration.

What Is the Risk? The EPA has developed toxicity values (see box below) to estimate the risk of getting cancer or other adverse health effects as a result of inhaling or ingesting chloroform. The toxicity value typically used for estimating the risk of getting cancer is called a slope factor (SF), and the value for the non-cancer effect is called a reference dose (RfD). An SF is an estimate of the chance that a person exposed to the chemical will get cancer from taking in one milligram per kilogram of body weight per day (mg/kg-day) for a lifetime. An RfD is an estimate of the highest dose that can be taken in every day without causing an adverse non-cancer effect. These toxicity values have been developed by studying test animals given relatively high doses over their lifetimes, then adjusting and normalizing those results to a mg/kg-day basis for humans. Because the carcinogenicity of chloroform occurs only at exposures resulting in cytotoxicity, the EPA has determined that use of the SF is not appropriate and that protecting against the non-cancer effects of oral exposure to chloroform is also protective against increased risk of cancer. Although the EPA still lists an inhalation SF for chloroform, this SF is currently under review and may be withdrawn in the future.

Chemical Toxicity Values	
Cancer Risk	**Non-Cancer Effect**
Inhalation SF	***Oral RfD***
(0.081 per mg/kg-day)	0.01 mg/kg-day

To illustrate how the RfD is applied, a 150-lb person could safely ingest 0.68 mg of chloroform every day without expecting any adverse effects (2.2 lbs = 1 kg, or 1000 grams, or 1 million mg). In contrast to the RfD, which represents a "safe daily dose" (and so is compared to the amount an individual takes in, as a ratio), the SF is multiplied by the amount taken in to estimate the cancer risk. Using the SF, the EPA estimates that a person would have a one-in-a-million chance of developing cancer if exposed to air containing 0.00004 milligram per cubic meter (mg/m^3) chloroform.

What Are Current Limits for Environmental Releases and Human Exposures? To help track facility releases to the environment, the Superfund amendments addressing emergency planning and community right-to-know require the immediate reporting of a release or spill of 10 pounds or more of chloroform and that normal releases be reported annually and entered into a nationwide Toxic Release Inventory. For drinking water supplies, the EPA has established a protective level (maximum contaminant level) of 100 ppb for trihalomethanes, a class of chemicals that includes chloroform. For air in the workplace, the Occupational Safety and Health Administration has set a "ceiling limit" of 50 ppm that is not to be exceeded at any time.

Where Can I Find More Information? More information on chloroform can be found in the primary information source for this overview: the Toxicological Profile for Chloroform prepared by the Agency for Toxic Substances and Disease Registry and available on the Internet at http://www.atsdr.cdc.gov/toxpro2.html. Several other sources of information are available on the Internet, including the ATSDR ToxFAQS (http://www.atsdr.cdc.gov/toxfaq.html), EPA's Integrated Risk Information System Database (http://www.epa.gov/iris/subst/index.html), and the Hazardous Substances Data Base (http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB).